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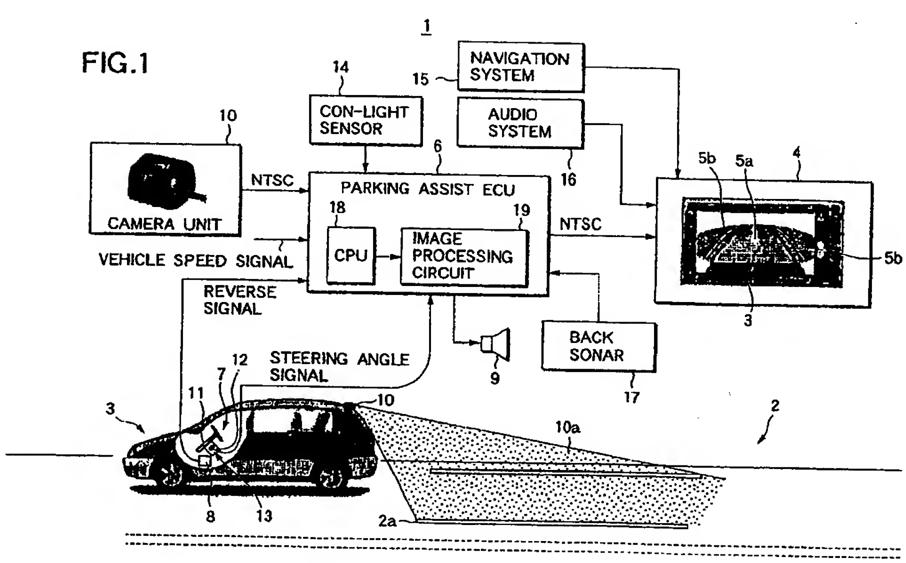
(54) Vehicle driving support system, and steering angle detection device

(57) A camera unit 10 is mounted on a vehicle 3. When an attempt is made to park the vehicle 3 in a parking lot, a predicted path 5a and guidelines 5b are displayed on an information display 4 together with an image. Data to be used for displaying the predicted path 5a and the guidelines 5b are stored beforehand in internal memory of an image processing circuit 19 provided in a parking assist ECU 6 so that the data can be selected in accordance with specifications, such as the type of the vehicle 3. The predicted path 5a is computed on the basis of a steering angle detected by a steering angle sensor provided in an exposed portion of the steering shaft 11. The length or color of the predicted path 5a is changed in accordance with the speed of the vehicle 3. Further, a vehicle driving support system is provided with a back sonar 17, and hence the length or color of the predicted path 5a is also changed in accordance with the result of detection of an obstacle.

FIG.1



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relationship between the vehicle and the obstacle.

[0007] Even when driving support is effected on the basis of an image, the driver must determine circumstances directly on the basis of his vision, and a display for assisting driving operation must be utilized for only auxiliary purpose. A limitation is imposed on the size of display means situated in the vicinity of a driver's seat. Display of a predicted path of a vehicle together with an image is preferable for effectively assisting driving operation. A predicted path of the vehicle corresponds to information-which the driver can never gain by means of looking directly at surroundings-and is very useful.

[0008] A predicted path of the vehicle displayed in an image captured by a camera or the like should be changed by an angle of the camera mounted on a vehicle body, a steering angle of the vehicle, the width of the vehicle body, and a wheelbase. A path cannot be accurately predicted without matching data pertaining to these items with an actual vehicle, and hence effective driving support cannot be effected. In terms of productivity of manufactured products, a driving support system is desirably mountable on vehicles of many types. Preferably, required data can be readily input in accordance with the specifications of an individual vehicle. Further, under the present circumstances, a vehicle is not usually provided with a sensor for detecting the steering angle of a vehicle, which is required for predicting a path. Therefore, simplest detection of a steering angle is desirable.

[0009] An object of the present invention is to rovide a vehicle driving support system and a steering angle detection device, which easily compensates for a difference in specifications of a vehicle on which the system is to be mounted, and which enables highly-accurate support.

[0010] Accordingly, the present invention provides a vehicle driving support system which captures an image of the surroundings of a vehicle through use of a camera and displays on display means driving support information along with the captured image, the system comprising:

a steering angle sensor for detecting a steering angle of a vehicle;
travel prediction means which predicts a travel path of the vehicle on the basis of a steering angle detected by the steering angle sensor and computes the thus-predicted travel path as a predicted travel curve;
memory in which, in connection with specifications of any of a plurality of vehicles, there are stored beforehand data pertaining to the space which would be occupied when a vehicle travels along a predicted travel curve computed by the travel prediction means;
selection operation means by way of which an input operation is performed for selecting data to be stored in the memory, in accordance with specifications of a vehicle; and
control means which computes, as driving support information, a path pertaining to a space by which the vehicle is predicted to pass in accordance with travel of the vehicle on the basis of the predicted travel curve predicted by the travel prediction means and through use of the data selected by means of an input operation of the selection operation means, and which causes the display means to display the computed path.

[0011] According to the present invention, the vehicle driving support system for displaying driving support information along with an image of the surroundings of a vehicle comprises a camera, displaymeans, a steering angle sensor, travel prediction means, memory, selection operation means, and control means. The steering angle sensor detects a steering angle of the vehicle. The travel prediction means predicts the travel path of the vehicle on the basis of the steering angle detected by the steering angle sensor and computes the thus-predicted travel path as a predicted travel curve. In memory, in connection with specifications of any of a plurality of vehicles there are stored beforehand data pertaining to the space which would be occupied when a vehicle travels along the predicted travel curve computed by the travel prediction means. By way of selection operation means, an input operation is performed for selecting data to be stored in the memory, in accordance with specifications of a vehicle.

[0012] On the basis of the predicted travel curve predicted by the travel prediction means, control means computes, as driving support information, a path pertaining to a space by which the vehicle is predicted to pass in accordance with travel of the vehicle, through use of the data selected by means of an input operation of the selection operation means. The thus-computed path is displayed on the display means. When the path is displayed on the display means along with an image, the predicted path is displayed so as to match the video to be displayed on the display means. A highly-accurate predicted path is displayed, to thereby provide easily-understandable driving support. Data pertaining to specifications of several types of vehicles are stored in memory beforehand. Consequently, a highly-accurate predicted path can be effected by means of selection of optimal data through use of the selection operation means, which is easier than selection by means of direct input of individual data sets.

[0013] Preferably, information concerning one or more of a wheeltread of the vehicle, a wheelbase of the vehicle, the amount of kingpin offset, and a height at which the camera is to be mounted is stored in the memory as the data.

[0014] According to the present invention, data pertaining to one or more of a wheeltread of the vehicle, a wheelbase of the vehicle, the amount of kingpin offset, and a height at which thecameraistobemountedare-

driving support system which captures an image of the surroundings of a vehicle through use of a camera and displays on display means driving support information along with the captured image, the system comprising:

a steering angle sensor for detecting a steering angle of a vehicle;
travel prediction means which predicts a travel path of the vehicle on the basis of a steering angle detected by the steering angle sensor and computes the thus-predicted travel path as a predicted travel curve;
memory in which there are stored beforehand data pertaining to the space which would be occupied when a vehicle travels along a predicted travel curve computed by the travel prediction means; and
control means which computes, as driving support information, a path pertaining to a space by which the vehicle is predicted to pass in accordance with travel of the vehicle on the basis of the predicted travel curve predicted by the travel prediction means and through use of the data selected by means of an input operation of the selection operation means, and which causes the display means to display the computed path,

wherein the control means changes the length or color of a path to be displayed, in accordance with the speed of the vehicle.

[0023] According to the present invention, the length or color of a predicted path to be displayed is changed whether the vehicle drives at a speed slower than a predetermined speed or is stationary. Therefore, driving support can be effected so as to match a vehicle speed while displaying whether the vehicle is driving or stationary.

[0024] Preferably, the control means changes the length or color of the path stepwise in accordance with the vehicle speed.

[0025] According to the present invention, the length or color of a predicted path is changed stepwise in accordance with the speed of the vehicle. Therefore, safety can be improved in accordance with the speed of the vehicle.

[0026] The present invention also provides a vehicle driving support system which captures an image of the surroundings of a vehicle through use of a camera and displays on display means driving support information along with the captured image, the system comprising:

a steering angle sensor for detecting a steering angle of a vehicle;
travel prediction means which predicts a travel path of the vehicle on the basis of a steering angle detected by the steering angle sensor and computes the thus-predicted travel path as a predicted travel curve;
memory in which there are stored beforehand data pertaining to the space which would be occupied when a vehicle travels along a predicted travel curve computed by the travel prediction means;
obstacle detection means for detecting an obstacle which is present in the travel direction of the vehicle; and
control means which computes, as driving support information, a path pertaining to a space by which the vehicle is predicted to pass in accordance with travel of the vehicle on the basis of the predicted travel curve predicted by the travel prediction means and through use of the data selected by means of an input operation of the selection operation means, and which causes the display means to display the computed path,

wherein the control means changes the length or color of the path, in accordance with the result of detection performed by the obstacle detection means.

[0027] According to the present invention, since the length or color of the path is changed in accordance with the result of obstacle detection performed by the obstacle detection means, the driver can readily ascertain the presence of an obstacle and acquire information about the distance to the obstacle. Thus, effective driving support can be provided for avoiding the obstacle.

[0028] Preferably, the obstacle detection means outputs one of predetermined detection signal of several stages in accordance with the distance to the detected obstacle, and the control means changes the length or color of the path in stages in accordance with a detection signal output from the obstacle detection means.

[0029] According to the present invention, since the length or color of a predicted path can be changed in accordance with the distance to an obstacle, driving support pertaining to an approach to an obstacle can be provided in an easily-understandable manner.

[0030] The present invention also provides a vehicle steering angle detector for detecting a steering angle of a vehicle from an exposed portion of a steering shaft which rotates in response to the actuation of a steering wheel, the exposed portion being located within a vehicle body, the detector comprising:

a steering angle sensor which detects the amount of angular displacement of the steering shaft at the exposed portion of the steering shaft; and
a bracket whose base end is secured to the vehicle body in the vicinity of the exposed portion of the steering shaft, by means of utilization of screws to be used for fixing bearings of the steering shaft to the vehicle body, and which has a geometry satisfying requirements for the vicinity of the steering shaft of the vehicle so that the steering angle sensor can be attached to the front end of the bracket.

[0031] According to the present invention, the steering angle of a vehicle can be detected through use of

the steering angle detector 12, and a signal representing the result of detection of a steering angle is input to the parking assist ECU 6. On the basis of the steering angle detected by the steering angle sensor 13, the parking assist ECU 6 calculates a predicted travel curve of the vehicle 3. On the basis of a wheelbase (i.e., the distance between the centers of the front and rear axle shafts), a wheel tread (i.e., the distance between the treads of tires provided on respective ends of an axle shaft), and/or the amount of kingpin offset, there is computed a predicted path 5a representing a space, which space would occupy when the vehicle travels along a predicted travel curve.

[0051] The manner in which the predicted path 5a is read on the display screen of the information display 4 varies with the position at which the camera unit 10 is mounted. The parking assist ECU 6 displays the predicted path 5a on the information display 4 through use of the position at which the camera 10 is mounted. Information about the position where the camera unit 10 is mounted is also utilized when the guidelines 5b showing the extensions of the sides of the vehicle body are displayed on the information display 4. The direction of the guidelines 5b is fixed with respect to the view field 10a of the camera unit 10. Therefore, the direction of the guidelines 5b is changed in accordance with the position at which the camera unit 10 is mounted.

[0052] The screen of the information display 4 is adjusted in accordance with the brightness of surroundings. The brightness of surroundings is detected by a con-light sensor 14 used for controlling an illuminating state of an illumination system of the vehicle 3 and is controlled on the basis of an output from the con-light sensor 14. The brightness and contrast of the illumination system are adjusted in accordance with the brightness of surroundings of the vehicle 3 detected by the con-light sensor 14, thereby effecting readily-comprehensible driving support.

[0053] In-car equipment, such as a navigation system 15 and audio equipment 16, is provided in the vehicle 3. A limitation is imposed on the operating speed of the navigation system 15 associated with driving of a vehicle, in accordance with the traveling speed of the vehicle 3. Provided that, for instance, 10 km/h is taken as a reference speed, the navigation system 15 is provided with the function of operating at only a speed lower than 10 km/h.

[0054] When the vehicle 3 travels backward, detection of obstacles on a road surface can be made through use of a back sonar 17. The back sonar 17 serving as obstacle detection means detects obstacles through use of ultrasonic waves. The parking assist ECU according to the present embodiment changes the displaying state of a display appearing on the information display 4, by means of utilization of an output from the back sonar 17.

[0055] The parking assist ECU 6 includes a CPU 18 for controlling the entire parking assist ECU 6 and an image processing circuit 19 which effects image processing for displaying an image on the information display 4. A signal indicating the speed of the vehicle 3 and a signal indicating a changed state of the transmission 8 enter the CPU 18, along with a signal output from the con-light sensor 14 and a signal output from the back sonar 17. On the basis of these signals, the CPU 18 can control the image processing circuit 19, to thereby change the state of an image appearing on the information display 4.

[0056] FIG. 2 shows the electrical configuration of the image processing circuit 19 included in the parking assist ECU 6 shown in FIG. 1. Image processing operations performed in the image processing circuit 19 are performed by a digital signal processor (hereinafter abbreviated "DSP"). An image captured by the camera unit 10 is input to an amplifier/filter circuit 22 in the form of an NTSC signal. The thus-input image is an analog signal, and hence an analog-to-digital converter (hereinafter abbreviated as "ADC") 23 converts the analog signal into a digital signal. The thus-converted digital signal is stored in a field buffer circuit 24. An image signal output from the amplifier/filter circuit 22 is also delivered to a synch separation circuit 25, in which a horizontal synch signal and a vertical synch signal are separated from the image signal. The thus-separated synch signals are input to the DSP 20.

[0057] A steering angle detection signal output from the steering angle sensor 13 is also input to the DSP 20 by way of the ADC 26. Inaccordancewithaprogramwhichhasbeenstoredinprogram memory 27 beforehand, the DSP 20 performs image processing. At the time of image processing, there are produced an image to be used for displaying the predicted path 5a and an image to be used for displaying the guidelines 5b, such as those shown in FIG. 1. These images are formed from the data previously stored in data memory 28, by means of computation. In the data memory 28 there are previously stored data pertaining to many types of vehicles. In connection with each type of vehicle, data comprise the width of a vehicle, a wheeltread representing the distance between the treads of tires provided at both ends of the axle shaft, a wheelbase indicating the distance between the center lines of the front and rear axle shafts, the amount of kingpin offset, and the position on a vehicle body in which the camera unit 10 is to be mounted. Not all these pieces of information are necessary. However, if all these pieces of information are available, the accuracy of prediction of a path can be improved. Since contents stored in backup memory 29 are preserved by means of a battery, data required to be backed up, such as data or parameters to be used when the DSP 20 performs image processing, can be stored.

[0058] An image produced as a result of image processing performed by the DSP 20 is stored in two field buffer circuits 31 and 32, in which selection between image signals output from the field buffer circuits

scale 43. A caution 44 is also included in a part of the image 40 for prompting direct visual check. FIG. 5 shows the second predicted path displayed in step alO shown in FIG. 3. FIG. 6 shows the third predicted path displayed in step all shown in FIG. 3.

[0065] The predicted path 41 included in each of the images 40 shown in FIGS. 4, 5, and 6 is changed in length and color. On the basis of data pertaining to a steering angle and a vehicle, the predicted path 41 is redrawn at all times. The right and left side lines of the vehicle and a range of area extending over 5 meters from the rear end of the vehicle are displayed. Since FIG. 4 shows no obstacles located near the vehicle, the predicted path 41 is displayed in red so as to extend to a range of, for example, about 0.5 meters. Since the vehicle 3 shown in FIG. 6 is stationary, the predicted path 41 is displayed in, for example, a light blue so as to extend to a range of 5 meters. The vehicle shown in FIG. 5 is in an intermediate state between the state shown in FIG. 4 and the state shown in FIG. 6. The predicted path 41 is displayed in, for example, orange and so extend to an intermediate range of about 2 meters.

[0066] The guidelines 42 shown in FIGS. 4 to 6 are displayed symmetrically while being fixed in the center of the information display 4. The area from a position 0.5 meters from the rear end of the vehicle to a position 5 meters from the same is displayed in the form of the guidelines 42. The range scale 43 indicating distance is displayed in conjunction with the guidelines 42. A wide-angle lens is used for the camera unit 10 in order to enable the driver to check obstacles within a range covering rear blind spots of the vehicle along with the display of the predicted path 41 and the guidelines 42.

[0067] FIG. 7 shows control procedures according to another embodiment for changing the length and color of the predicted path 41, which is shown in FIGS. 4, 5, and 6, in accordance with only a speed. In the present embodiment, processing pertaining to steps a5 and al8 to a20 is not performed. In the present embodiment, processing pertaining to steps b0 to b4 and processing pertaining to steps b6, b8, and b10 to b17 are equal to processing pertaining to steps a0 to a4, a6, a8, and a10 to a17 shown in FIG. 3. In the present embodiment, after a steering angle has been detected in step b6, in step b7 a determination is made as to whether or not the vehicle speed of the vehicle exceeds the speed of a second stage; for example, a speed of 5 km/h. If the speed is determined to exceed a speed of 5 km/h, the predicted path 41 of first stage is displayed in step b8. If in step b7 the speed is determined to not exceed 5 km/h, in step b9 a determination is made as to whether or not the speed is greater than 0; that is, whether the speed is greater than 0 and lower than 5 km/h. If it is determined that the vehicle is not stationary, in step b10 the second predicted path is displayed. In contrast, if it is determined that the vehicle is stationary, in step b11 the third predicted path is displayed.

[0068] FIG. 8 shows control procedures according to still another embodiment, wherein a warning is changed in accordance with the distance to an obstacle, by means of combination of emission of continuous beep sound and intermittent beep sound after the back sonar 17 has detected the obstacle. When the distance to an obstacle becomes less than a predetermined value, the back sonar 17 emits a continuous beep sound. In contrast, if a distance is greater than a predetermined value, the back sonar 17 emits an intermittent beep sound. In the present embodiment, the display shown in FIG. 4 and the display FIG. 5 are made to correspond to each other. In the event that no obstacles are detected, a display such as that shown in FIG. 6 is displayed. A change in the display reflects on only the back sonar 17. The present embodiment is analogous to that shown in FIG. 7, except that in steps c7 and c9 shown in FIG. 8 the mode of display of a predicted travel path is changed in accordance with a change in the signal output from the back sonar 17. Processing pertaining to steps c0 to c6, c8, and c10 to c17 is equal to that pertaining to steps b0 to b6, b8, and b10 to b17 shown in FIG. 7.

[0069] In the embodiments which have been described above, the length and color of the predicted path 41 and those of the guidelines 42 are changed in accordance with a vehicle speed or a distance to an obstacle. Either the length or color of the predicted path 41 and either the length or color of the guidelines 42 may be changed. Alternatively, the length and color of the predicted path 41 and those of the guidelines 42 may be changed continuously with a vehicle speed or a distance to an obstacle. In any event, the driver can ascertain a change in circumstances.

[0070] FIG. 9 is an exploded view of configuration of the steering angle detector 12 shown in FIG. 1. The steering angle detector 12 is supported by a mount bracket 50 attached to the vehicle body. A shaft gear 51 is attached to the steering shaft 11. The shaft gear 51 can be separated into two pieces and can be fitted around the steering shaft 11 from the sides thereof. Angular displacement transmitted from the steering shaft 11 to the shaft gear 51 is transmitted to a detection gear 52 attached to the rotary shaft of the steering angle sensor 13 . The steering angle sensor 13 is attached to the mount bracket 50 such that the detection gear 52 meshes with the shaft gear 51. The shaft gear 51 is fitted around the steering shaft 11 by way of a spacer 53, even when the outer diameter of the steering shaft 11 differs in accordance with the type of a vehicle. A change in the outer diameter of the steering shaft 11 due to a change in the type of vehicle can be accommodated by means of a change in the thickness of the spacer 53. The steering angle sensor 13 and the detection gear 52, which are attached to the mount bracket 50, and the shaft gear 51 attached to the steering shaft 11 are accommodated in the space defined by combination of unit covers 54 and 55. Unit covers 54 and 55 are fastened to the steering shaft 11, through use of fastening screws 57. The mount bracket 50 is attached to bolts projecting from the

ment. When the vehicle speed of the vehicle increases, it is desirable for the driver to check the surroundings through use of his sight rather than on the basis of information displayed on the display means. Thus, there is prevented diversion of driver's attention, which would otherwise be caused by display means, thus improving safety.

[0081] According to the present invention, the length or color of a predicted path is changed in accordance with vehicle speed, thereby enabling appropriate driving in accordance with the driving state of the vehicle.

[0082] According to the present invention, the length and color of a predicted curve are changed stepwise in accordance with vehicle speed. Therefore, driving support can be effected while the degree of safety is improved in accordance with vehicle speed.

[0083] According to the present invention, the length or color of a predicted path of the vehicle is changed on the basis of the result of detection of an obstacle. In the event of an obstacle being present along the path of the vehicle, an easily-understandable display is providing as the vehicle approaches the obstacle, thus improving safety.

[0084] According to the present invention, in the event that obstacle detection means has detected an obstacle, predetermined detection signals corresponding to a plurality of steps are output in accordance with the distance to the obstacle. The length or color of a predicted path to be displayed on display means is changed in response to an output detection signal. The result of detection performed by the obstacle detection means is made to correspond to the display of a path, thus facilitating focusing of attention on an approach to the obstacle.

[0085] According to the present invention, even in the case of a vehicle which is not equipped with the function of detecting steering angle, the rotation of a steering shaft can be detected by way of an exposed portion of the steering shaft, and the thus-detected steering angle can be used for predicting a path.

[0086] According to the present invention, the rotation state of the steering shaft is detected by a splittable shaft gear. The thus-detected rotating state is transmitted to a detection gear. The rotation state of the detection gear is detected by a steering angle sensor as a variation in steering angle. Therefore, a steering angle can be readily detected from the steering shaft. Although the location of an exposed portion of the steering shaft varies according to the type of the vehicle of interest, a difference in type of vehicle can be compensated for by means of selection of brackets of different shapes. A steering angle sensor is readily mounted on a plurality of types of vehicles, thus rendering the steering sensor sharable among vehicles.

[0087] According to the present invention, the shaft gear to be attached to a steering shaft is splittable. Hence, the shaft gear can be easily attached to an exposed portion of the steering shaft. The rotation of state of the steering shaft is transmitted to the detection gear. The steering angle sensor can readily detect the rotation state of the detection gear resulting from rotation of the steering shaft. So long as the shaft gear is formed so as to differ in the number of teeth from the detection gear or such that the number of teeth of the shaft gear is greater than that of the detection gear, the rotation angle of the detection gear becomes greater than that of the steering angle. Therefore, the accuracy of the steering angle detected by the steering angle sensor can be improved.

Claims

1. A driving support system for a vehicle comprising:

    a camera for capturing an image of surroundings of the vehicle;
    a steering angle sensor for detecting a steering angle of the vehicle;
    a travel prediction section for predicting a travel path of the vehicle on the basis of the steering angle detected by the steering angle sensor to calculate a predicted travel curve based on the travel path predicted;
    a memory storing data on specification for each of different types of vehicle, the data on specification pertaining to a space occupied by each of the different types of vehicle when the vehicle moves along the predicted travel curve obtained by the travel prediction section;
    a selection operation section for allowing an user to select a specific data for the vehicle from the data for the different types of vehicle;
    a controller for computing a path pertaining to a space where the vehicle is to pass in accordance with the movement of the vehicle, on the basis of the predicted travel curve predicted by the travel prediction section, using the specific data selected by the user's selection in the selection operation section; and
    a display section for displaying the path calculated in the controller and the image captured by the camera.

2. The driving support system as defined in claim 1, wherein the data in the memory comprises information concerning a wheeltread of the vehicle, a wheelbase of the vehicle, the amount of kingpin offset, or a height at which the camera is to be mounted.

3. A driving support system for a vehicle comprising:

    a camera for capturing a image of surroundings of the vehicle;
    a steering angle sensor for detecting a steering

path of the vehicle on the basis of the steering angle detected by the steering angle sensor to calculate a predicted travel curve based on the travel path predicted;
a memory storing data on specification of the vehicle, the data on specification pertaining to a space occupied by the vehicle when the vehicle moves along the predicted travel curve obtained by the travel prediction section;
an obstacle detecting section for detecting an obstacle which is present in a travel direction of the vehicle;
a controller for computing a path pertaining to a space where the vehicle is to pass in accordance with the movement of the vehicle, on the basis of the predicted travel curve predicted by the travel prediction section, using the data on specification of the vehicle; and
a display section for displaying the path computed in the controller and the image captured by the camera,

wherein the controller changes the length or color of the path, in accordance with a detection result performed by the obstacle detecting section.

11. The vehicle driving support system as defined in claim 8, wherein the obstacle detecting section outputs one of a plurality of predetermined detection signals each indicating a different level from others, in accordance with a distance to the obstacle detected, and the controller changes the length or color of the path in stepwise according to the one of the detection signals output from the obstacle detecting section.

12. A vehiclur steering angle detector comprising:

a steering angle sensor for detecting the amount of angular displacement of a steering shaft at an exposed portion of the steering shaft; and
a bracket whose base end is secured to a vehicle body in the vicinity of the exposed portion of the steering shaft by a screw used for fixing a bearing of the steering shaft to the vehicle body,

wherein the steering sensor is attached to a front end of the bracket.

13. The vehiclur steering angle detector as defined in claim 12, wherein the bracket has a shape suitable for a shape of the vicinity of the steering shaft of the vehicle so that the steering angle sensor is attached to the front end of the bracket.

14. The vehiclur steering angle detector as defined in claim 12, wherein the steering shaft rotates in response to an actuation of a steering wheel.

15. The vehicle steering angle detector as defined in claim 12 further comprising:

a splittable shaft gear fitted around the exposed portion of the steering shaft; and
a detection gear rotatably supported by the bracket, the detection gear meshing with the shaft gear,

wherein a rotation condition of the detection gear is detected by the steering angle sensor.

FIG.2

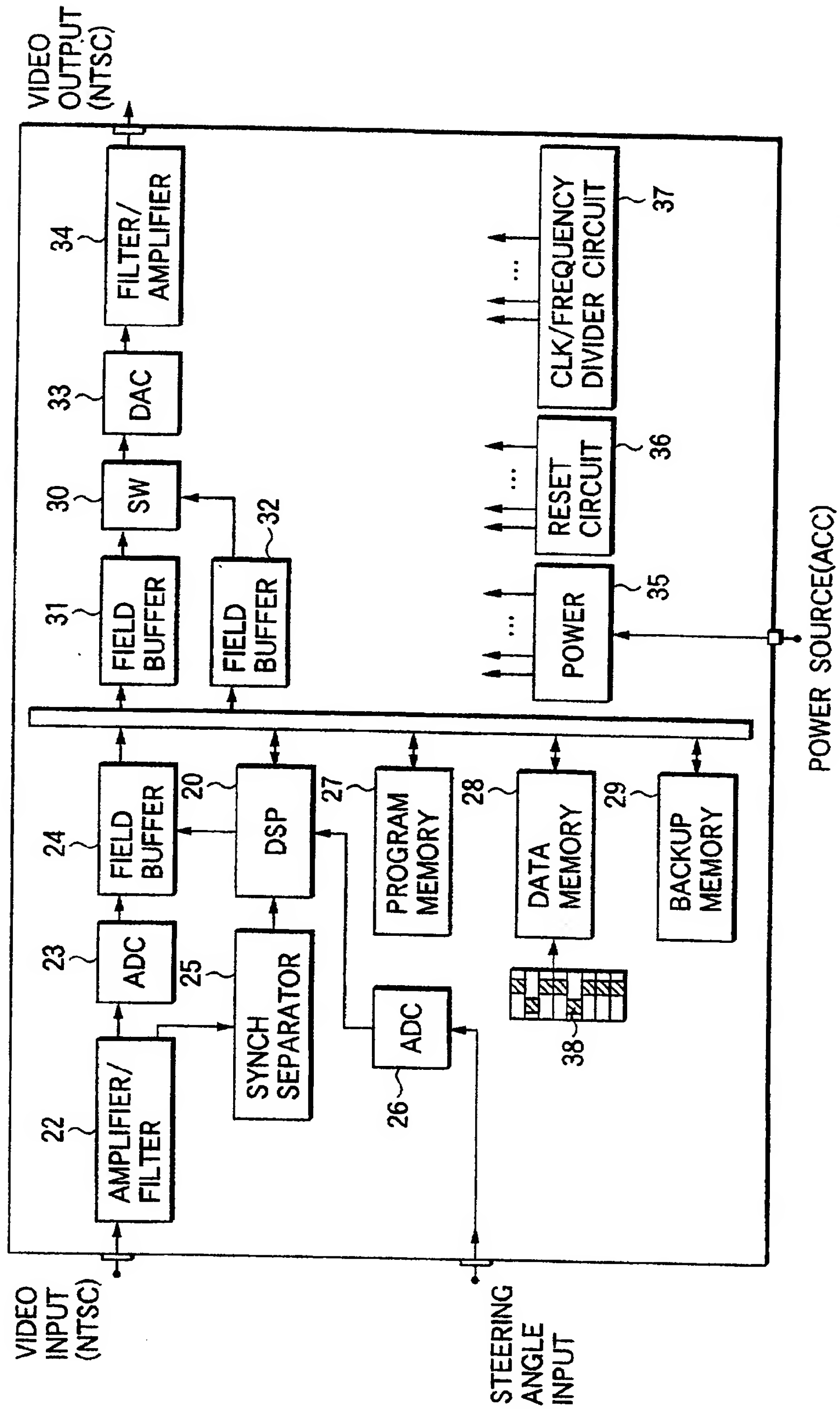
VIDEO INPUT (NTSC)
STEERING ANGLE INPUT
VIDEO OUTPUT (NTSC)
POWER SOURCE(ACC)
AMPLIFIER/ FILTER
22
ADC
23
FIELD BUFFER
24
SYNCH SEPARATOR
25
DSP
20
ADC
26
PROGRAM MEMORY
27
DATA MEMORY
28
BACKUP MEMORY
29
38
FIELD BUFFER
31
FIELD BUFFER
32
SW
30
DAC
33
FILTER/ AMPLIFIER
34
POWER
35
RESET CIRCUIT
36
CLK/FREQUENCY DIVIDER CIRCUIT
37

FIG.4

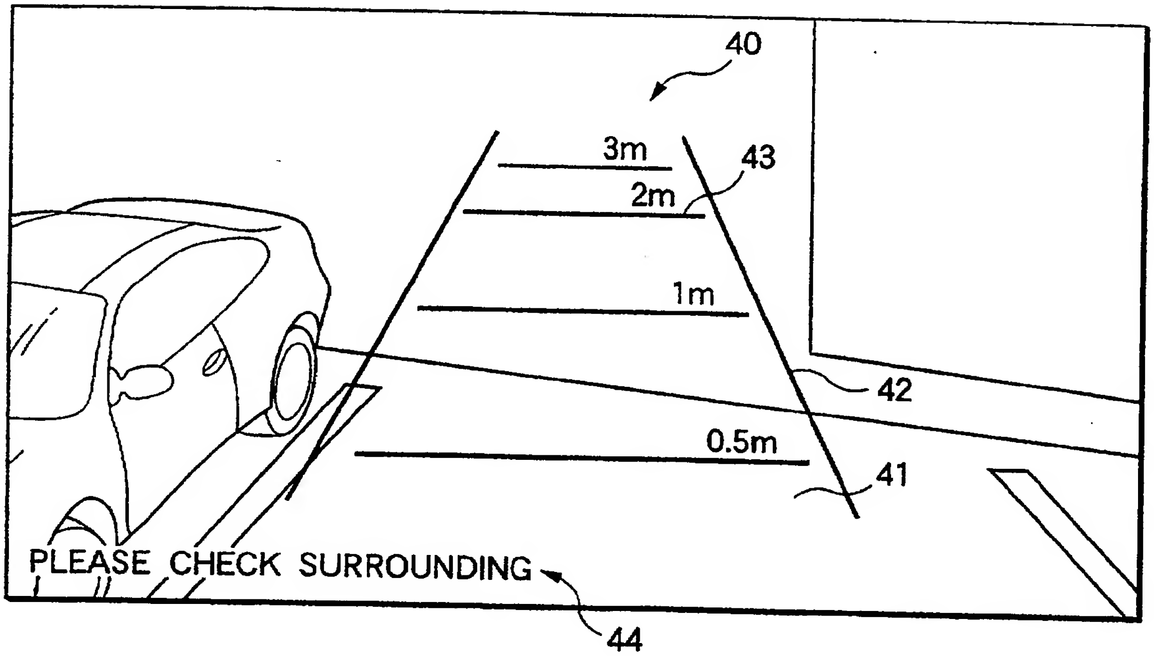

FIG.6

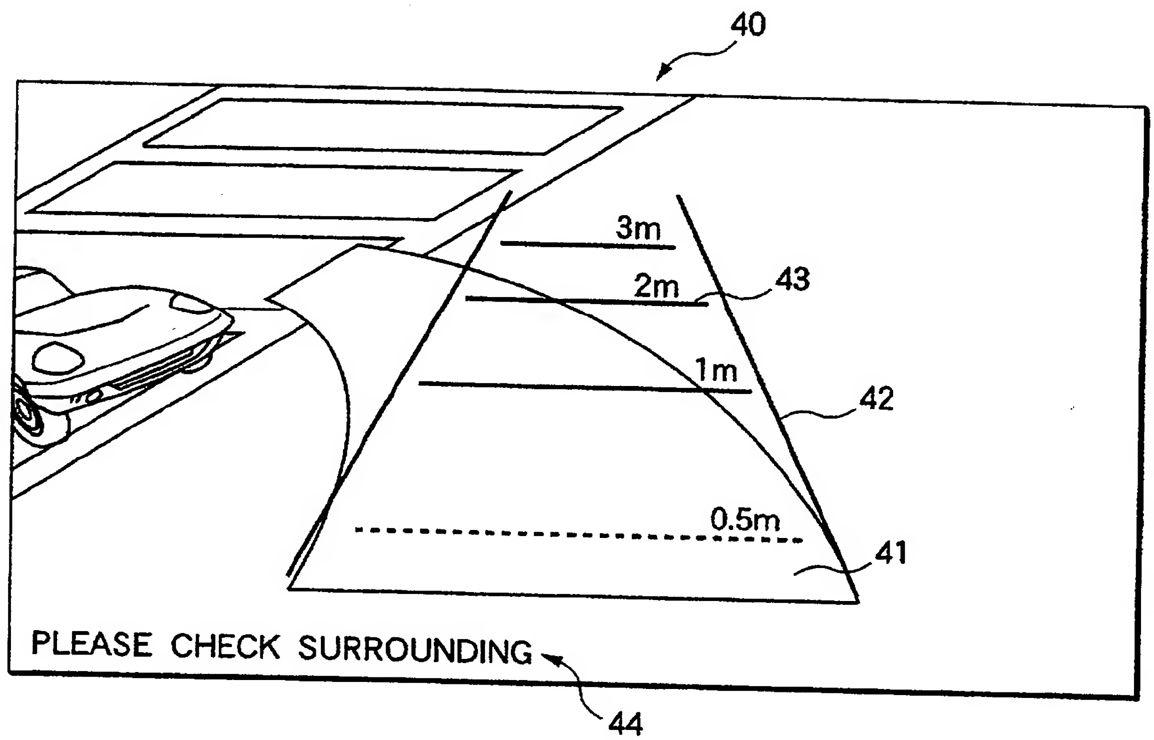

FIG.8

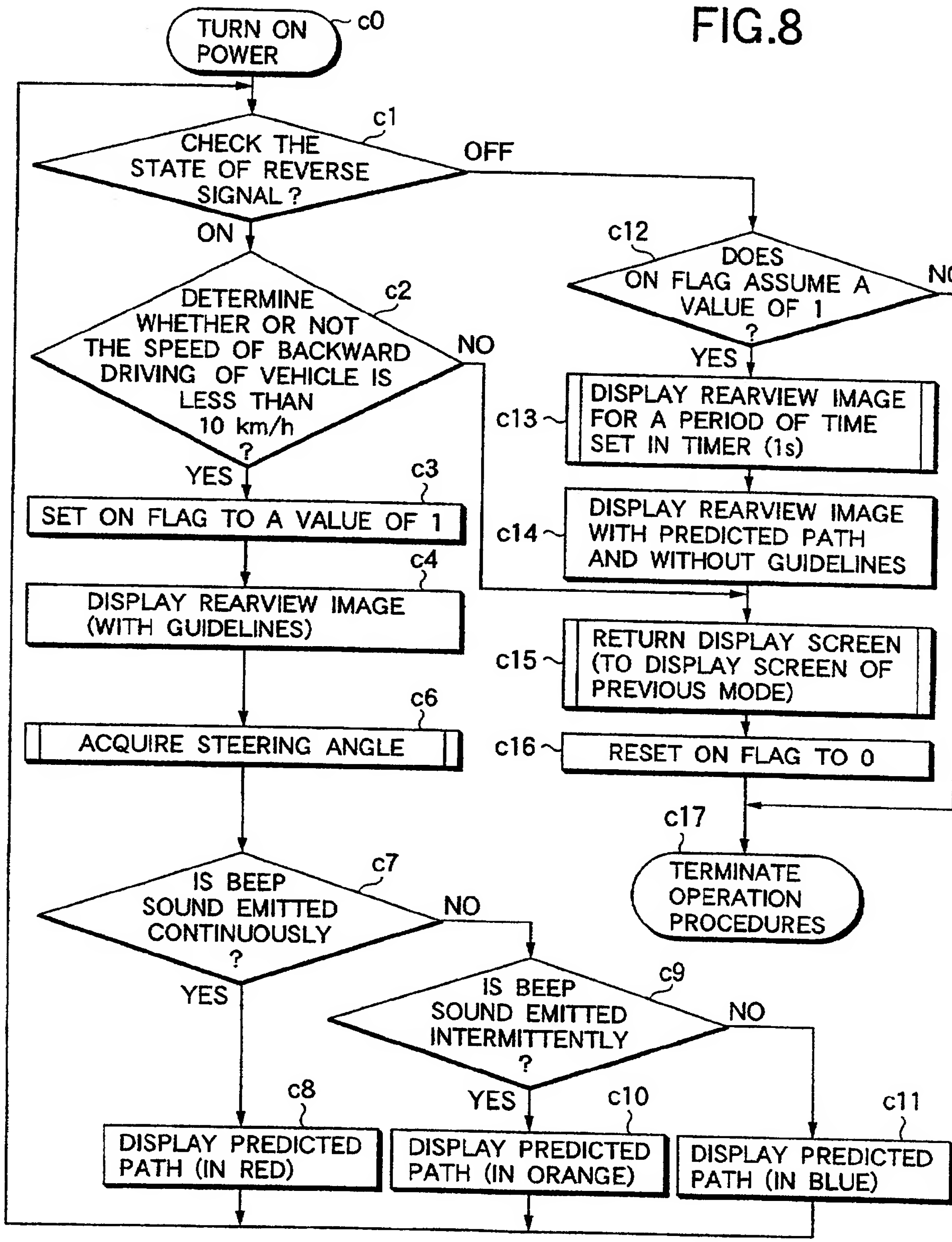
TURN ON POWER
c0
CHECK THE STATE OF REVERSE SIGNAL ?
c1
OFF
ON
DETERMINE WHETHER OR NOT THE SPEED OF BACKWARD DRIVING OF VEHICLE IS LESS THAN 10 km/h ?
c2
NO
YES
SET ON FLAG TO A VALUE OF 1
c3
DISPLAY REARVIEW IMAGE (WITH GUIDELINES)
c4
ACQUIRE STEERING ANGLE
c6
IS BEEP SOUND EMITTED CONTINUOUSLY ?
c7
NO
YES
IS BEEP SOUND EMITTED INTERMITTENTLY ?
c9
NO
YES
DISPLAY PREDICTED PATH (IN RED)
c8
DISPLAY PREDICTED PATH (IN ORANGE)
c10
DISPLAY PREDICTED PATH (IN BLUE)
c11
DOES ON FLAG ASSUME A VALUE OF 1 ?
c12
NO
YES
DISPLAY REARVIEW IMAGE FOR A PERIOD OF TIME SET IN TIMER (1s)
c13
DISPLAY REARVIEW IMAGE WITH PREDICTED PATH AND WITHOUT GUIDELINES
c14
RETURN DISPLAY SCREEN (TO DISPLAY SCREEN OF PREVIOUS MODE)
c15
RESET ON FLAG TO 0
c16
TERMINATE OPERATION PROCEDURES
c17

FIG.11A

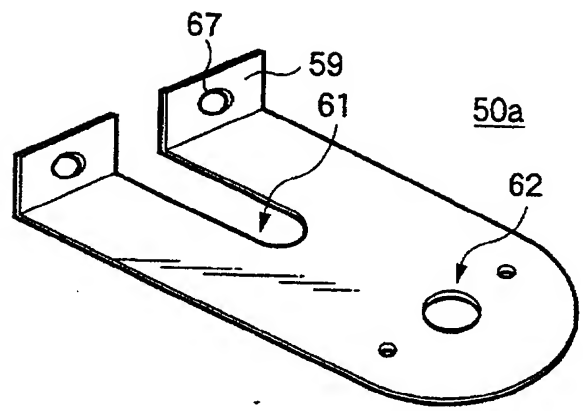

FIG.11B

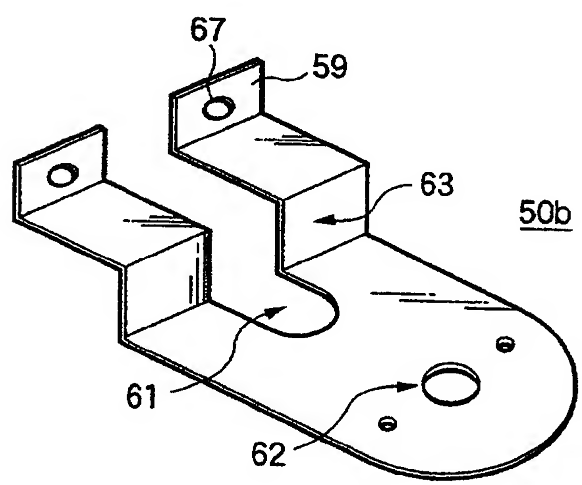

FIG.13A

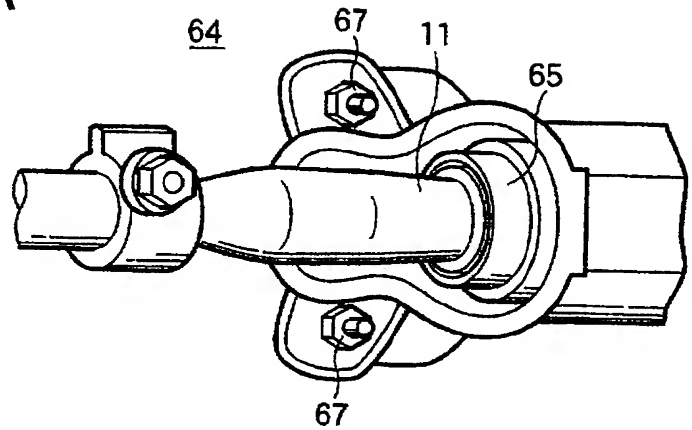

FIG.13B

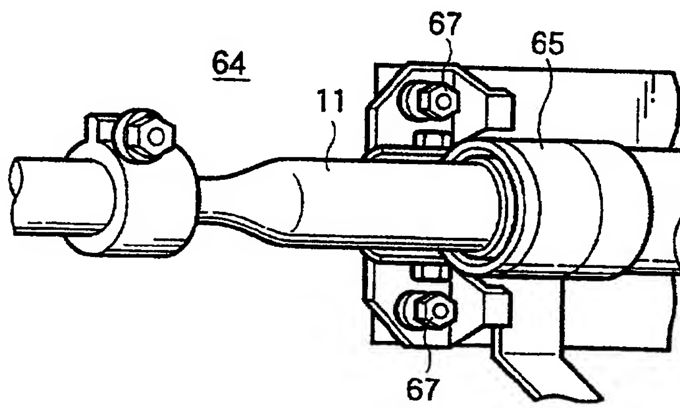

FIG.13C